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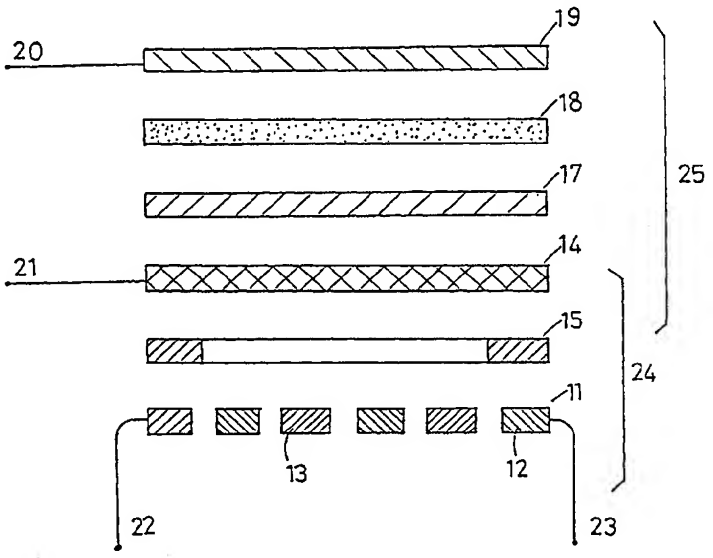
(54) Title: ILLUMINATED MEMBRANE SWITCH



(57) Abstract

An electroluminescent switch is described incorporating an electroluminescent lamp assembly (25) and one or more membrane switch assembly (24). The base electrode (21, 14) of the electroluminescent lamp additionally functions as the means by which the membrane switch may be closed upon actuation by a user. The membrane switch (24) can be constructed from two electrodes arranged so that the conductive layer when brought into contact with said electrodes shorts the electrodes thereby closing the circuit. Applications for the membrane switch (24) include electronic devices where panel switches are required or electronic devices requiring particularly thin switches which are to be backlit.

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ILLUMINATED MEMBRANE SWITCH

Field of the Invention

The present invention relates to combined lamp/membrane switch assemblies. More particularly, although not exclusively, the present invention relates to a membrane switch and electroluminescent lamp panel combined to form a discrete unit in which a number of components serve functions relating to the operation of both switch and lamp.

Membrane switches are well known in the art and generally refer to electrical switches constructed from at least two layers of plastic, or similar, film facing each other wherein one film carries at least two electrodes and the other is adapted to short the electrodes when the two films are pressed together. In a common embodiment, one of the faces of the plastic film carries an array of conducting tracks. The array corresponds essentially to two electrodes which, when shorted, complete the circuit. Such an electrode array is usually formed in a pattern of interlocking, "finger-like", tracks. This increases the likelihood that if a conductor is brought into contact with the surface the electrodes are shorted.

Background to the Invention

The surface of the plastic film facing this array of conductive tracks is either coated with a conducted material or the plastic film may be substituted with a conducting layer. A spacer element is interposed between the two opposing plastic surfaces. The spacer element has dimensions and geometry so that when pressure is applied to the membrane switch, the juxtaposed conductive layer and electrode array are brought together, whereupon the conductive layer shorts at least two of the electrode connections thereby completing the circuit and closing the switch.

The spacer layer may be formed from a paper, card layer or a die cut plastic film layer having an aperture or apertures located between the contacts of the electrode array on the surface of one of the films and the conducting layer on the opposing surface of the opposite film.

Such membrane switches are usually manufactured by laminating the respective layers onto substrate surfaces.

Electroluminescent (hereinafter referred to as EL) devices, as known in the art, can broadly be described as a capacitive device wherein a planar base electrode is separated from a planar transparent electrode by a phosphorescent layer with dielectric layer interposed between the two planar electrodes. When an AC voltage is applied across the conductive electrodes (i.e. the capacitive plates), the current induced between the base and the transparent electrode causes the phosphor layer to emit light. The light is visible through the transparent electrode. A variety of phosphorescent layer compositions can be used to provide various colours. Alternatively, or in combination, the transparent electrode may be itself coloured.

EL devices are advantageous in that they are relatively thin and may be manufactured by mass production lamination and/or printing techniques. EL devices are particularly adapted to switch arrays for use on panels or instruments which would normally be required to be backlit by some type of lamp and focusing assembly which projects light onto a translucent layer. This is intended to give the impression of a lit panel. The use of an EL device dispenses with the need for a physical (usually incandescent) lamp, focusing or light dispersion device and the hardware associated therewith. Accordingly, membrane switches are particularly suitable for applications where there is little or no room available for back lit physical switches or in similar applications where flat switch arrays are required.

Unless the membrane switch incorporates a tactile feedback component, such as a "clicking device" embedded in the switch assembly itself, a user is generally provided with no indication as to whether the switch has been actuated or not. Other means of providing such feedback include providing an LED which illuminates when the switch content is closed or a backlit membrane switch which itself is illuminated upon the switch being closed. EL devices are particularly suitable for combination with membrane switches and a number of prior art documents have addressed these applications. The reader is referred to US Patent No. 4,683,360 and US 4,060,703 for a useful discussion. The latter case describes essentially a discrete continuously lit EL lamp embedded in a "bubble" type membrane switch.

When used in situations such as panel switches or flat array instruments, it is desirable that the lamp/switch device be as thin as practicable. A number of prior art devices have attempted to address this problem by mounting a membrane switch next to a flat EL lamp. Such constructions, while being useful, are not particularly well suited to situations where the switch itself is required to be illuminate upon actuation or where shapes, patterns or letters are to be illuminated in response to touching or pressing the general area corresponding to that shape or pattern.

Accordingly, it is an object of the present invention to overcome some of the abovementioned difficulties and to provide a combination EL lamp and membrane switch which is thin, adaptable to manufacture and is particularly suitable for flat array or panel switch assemblies. It is a further object of the invention to provide an attractive and compact lamp/switch assembly or to at least provide the public with a useful choice.

Disclosure of the Invention

In one aspect the invention provides for a electroluminescent switch comprising:

one or more electroluminescent lamp assemblies and one or more membrane switch assemblies, wherein the electroluminescent lamp includes a base electrode which additionally functions as the means by which the membrane switch is closed upon actuation by a user.

Preferably the electroluminescent lamp/membrane switch comprises:

a membrane switch comprising:

at least two electrodes arranged so that upon bringing a conductive layer in contact with said electrodes, the electrodes are shorted;

a conductive layer covering at least two of the electrodes;

a spacer interposed between the conductive layer and the at least two electrodes, the spacer being adapted to hold the conductive layer away from the at least two electrodes while allowing the conductive layer to come into contact with the at least two electrodes upon the application of pressure by a user;

a electroluminescent lamp comprising:

a rear electrode;

a substrate layer juxtaposed over the rear electrode wherein a phosphor layer and dielectric layer are interposed between the rear electrode and a substrate layer;

wherein the rear electrode of the electroluminescent lamp and the conductive layer of the membrane switch are the same element.

Preferably the at least two electrodes are in the form of a conductive array deposited on a supporting layer wherein the conductive array is adapted so that when a conductive layer is pressed thereupon, the at least two electrodes are shorted.

Preferably the at least two electrodes are in the form of an array of intermeshed tracks formed on a supporting means.

Preferably the dielectric layer is superimposed over the rear electrode wherein the phosphor layer is superimposed on top of the dielectric layer and the substrate layer is superimposed upon the phosphorous layer.

Preferably the at least two electrodes activate devices including a driving circuit adapted to supply a current to the electroluminescent device.

Brief Description of the Drawings

The present invention will now be described by way of example only and with reference to the accompanying figures in which:

Figure 1 illustrates a cross section view of a combined electroluminescent device and membrane switch;

Figure 2 illustrates a perspective of an exploded view of a combined electroluminescent device and membrane switch.

The electroluminescent device will herein after be referred to as an EL device for brevity.

Referring to figure 1 a combined EL lamp and switch assembly is shown in cross section.

The membrane switch is referred to by the numeral 24 and comprises two electrodes 22 and 23 connected to an electrode array 11. The electrode array (more clearly seen in figure 2) is composed of a plurality of tracks 12 and 13. The tracks 12 and 13 are connected to electrode 22 and 23 respectively. Figure 2 illustrates a perspective view of each array of tracks 12 and 13 showing their intermeshed, but broken circuit, arrangement.

A spacer layer 15 is superimposed over the electrode array 11. The spacer element incorporates an aperture 16 formed so that at least some of the pairs of electrodes 12 and 13 forming the array 11 are accessible therethrough. A conductive layer 14 is superimposed upon the separating layer 15.

The idealised membrane switch 24 is operated by a user exerting a force downward onto the layer 14 thus bringing the conductive layer 14 into contact with the electrode array. This action shorts at least two of the track pairs 12 and 13 thus completing the switch circuit and closing the circuit formed by electrodes 22 and 23.

The membrane switch construction 24 is a particular example thereof and there exist a number of variations known in the art. They do, however, operate on a similar principle whereby at least two electrodes are shorted by the action of bringing a conductive layer or track in contact with an array or configuration of the electrodes. The array 11 is generally supported on a film or substrate layer (not shown). The tracks 12 and 13 may be formed by vacuum deposition of a metal or similar techniques which are known in the art.

Referring now to the EL device, a phosphor layer 18 and dielectric 17 are sandwiched between a printed substrate 19 and a rear electrode 14 (also the conductive shorting element

in the membrane switch). When an AC voltage is applied to the electrodes 20 and 21 the phosphor layer emits light which is visible through the transparent substrate.

The EL device 25 is driven by a high frequency AC circuit (not shown) and it is considered that construction of such a driver circuit is within the purview of one skilled in the art.

The membrane switch 24 and EL device 25 are manufactured by laminating the layers together in a sandwich thereby forming an extremely thin, self contained, self illuminating switch device. The key feature being that the conductive layer 14 acts as both the means by which the electrodes of the membrane switch are shorted, as well as one of the electrodes of the EL device.

The substrate layer 19 may incorporate printed matter or subsequent layers deposited thereupon.

Figure 2 illustrates a perspective of an exploded view of an exemplary lamp/switch of the present invention. It can be seen that the electrode array 11 is formed by a meshed array of branched electrodes 12 and 13 which are, in the absence of any means by which they are shorted, electrically insulated from each other thereby constituting an open switch. The spacer 15 incorporates, in this example, a circular aperture juxtaposed on top of the track array 11. The spacer may be formed from card, paper or a similar non-conductive material. A conductive layer 14 is held away from the track array 11 by means of the spacer. The particular intermeshing geometry of the array 11 is used so that the switch will be responsive to pressure on as large an area of the switch as possible. That is, any pair of opposing open electrodes may be shorted in order to close the switch circuit. Such shorting is effected by a user pressing down on the layer 14 thus bringing the conductive layer into contact with some portion of the electrode array surface.

The components of the EL device are in the form of relatively thin films and are flexible to the extent that when a user presses down on the printed substrate, force is transmitted through the phosphor layer and the dielectric layer thereby bringing the rear electrode 14 into contact with the electrode array 11 thereby completing the circuit and closing the switch. The switch closure can, not only be used to activate the desired switch function but also to activate a driving circuit which illuminates the EL device in response to the user's pressing thereupon.

Accordingly, a self illuminating lamp/membrane switch assembly is provided which is compact and may be manufactured in the form of a discrete unit having electrodes which may be easily connected to external switching and driving circuitry.

While the particular example shows an "ON" switch with a single membrane switch included, it is considered within the scope of the present invention that arrays of switches, such as those found in cash registers, computers and the like may be manufactured according to the present invention.

Further the present invention may be suitably adapted to artistic or advertising arrays whereby a user may press particular areas of such a printed array whereupon a shape or pattern is illuminated in response to the user's action.

The printed substrate is typically composed of a polyester sheet which acts as the upper capacitor plate when the EL device is energised. The phosphor layer is composed of materials which are commercially available and one known in the art. Their particular selection will depend on the colour of the light to be emitted and the manufacturing conditions under which the switch/lamp is to be produced.

The dielectric may be composed of Barium Titanate in combination with binder resins as are known in the art. The rear electrode, in this example, is composed of a silver layer thus providing particularly good conductive qualities. However, similar metals or materials may be substituted if required.

The track array 11, in this example, may be vacuum deposited or printed upon a supporting substrate (not shown).

It is also envisaged that the membrane switch may incorporate a tactile feedback means such as a *clicking* element which provides the user with tactile and/or audible feed back in combination with the visual feedback of the lamp being illuminated upon activating the membrane switch.

The present invention is particularly suitable for use in mass lamination manufacturing techniques. The various electrode connections may be traced to the edge of a planar EL lamp array to a standard type of connector which may be attached to appropriate driving and switching circuitry. The present invention thus provides a combination EL lamp/ membrane switch assembly which can be manufactured relatively cheaply and easily, and further provides particularly useful functionality in applications where a thin, self illuminating switch assembly is required.

It is envisaged that such applications may include photocopiers, cash registers, car panels and instrument control arrays such as those found in oscilloscopes and similar devices.

It is further envisaged that the self-illuminating switches may find particular applications in environments where carefully controlled lighting characteristics are required, such as on aircraft flight decks or on car instrument panels. In these situations, the user is provided

with positive visual feedback corresponding to the actuation of the switch and its associated function.

Where in the foregoing description reference has been made to elements or integers having known equivalents, then such integers are included as if they were individually set forth.

Although the present invention has been described with reference of an example and an embodiment thereof, it is envisaged that variations and modifications may be made thereto without departing from the scope of the appended claims.

CLAIMS:

1. An electroluminescent switch comprising:

one or more electroluminescent lamp assemblies and one or more membrane switch assemblies, wherein the electroluminescent lamp includes a base electrode which additionally functions as the means by which the membrane switch is closed upon actuation by a user.

2. An electroluminescent lamp/membrane switch comprising:

a membrane switch comprising:

at least two electrodes arranged so that upon bringing a conductive layer in contact with said electrodes, the electrodes are shorted;

a conductive layer covering at least two of the electrodes;

a spacer interposed between the conductive layer and the at least two electrodes, the spacer being adapted to hold the conductive layer away from the at least two electrodes while allowing the conductive layer to come into contact with the at least two electrodes upon the application of pressure by a user;

a electroluminescent lamp comprising:

a rear electrode;

a substrate layer juxtaposed over the rear electrode wherein a phosphor layer and dielectric layer are interposed between the rear electrode and a substrate layer;

wherein the rear electrode of the electroluminescent lamp and the conductive layer of the membrane switch are the same element.

3. An electroluminescent lamp/membrane switch as claimed in claim 2 wherein the at least two electrodes are in the form of a conductive array deposited on a supporting layer wherein the conductive array is adapted so that when a conductive layer is pressed thereupon, the at least two electrodes are shorted.

4. An electroluminescent lamp/membrane switch as claimed in either claim 2 or 3 wherein the at least two electrodes are in the form of an array of intermeshed tracks formed on a supporting means.

5. An electroluminescent lamp/membrane switch as claimed in any one of claims 2 to 4 wherein the dielectric layer is superimposed over the rear electrode wherein the phosphor layer is superimposed on top of the dielectric layer and the substrate layer is superimposed upon the phosphorous layer.

6. An electroluminescent lamp/membrane switch as claimed in any one of claims 2 to 5 wherein the at least two electrodes activate devices including a driving circuit adapted to supply a current to the electroluminescent device.

7. An electroluminescent lamp/membrane switch substantially as herein described and with reference to the drawings.

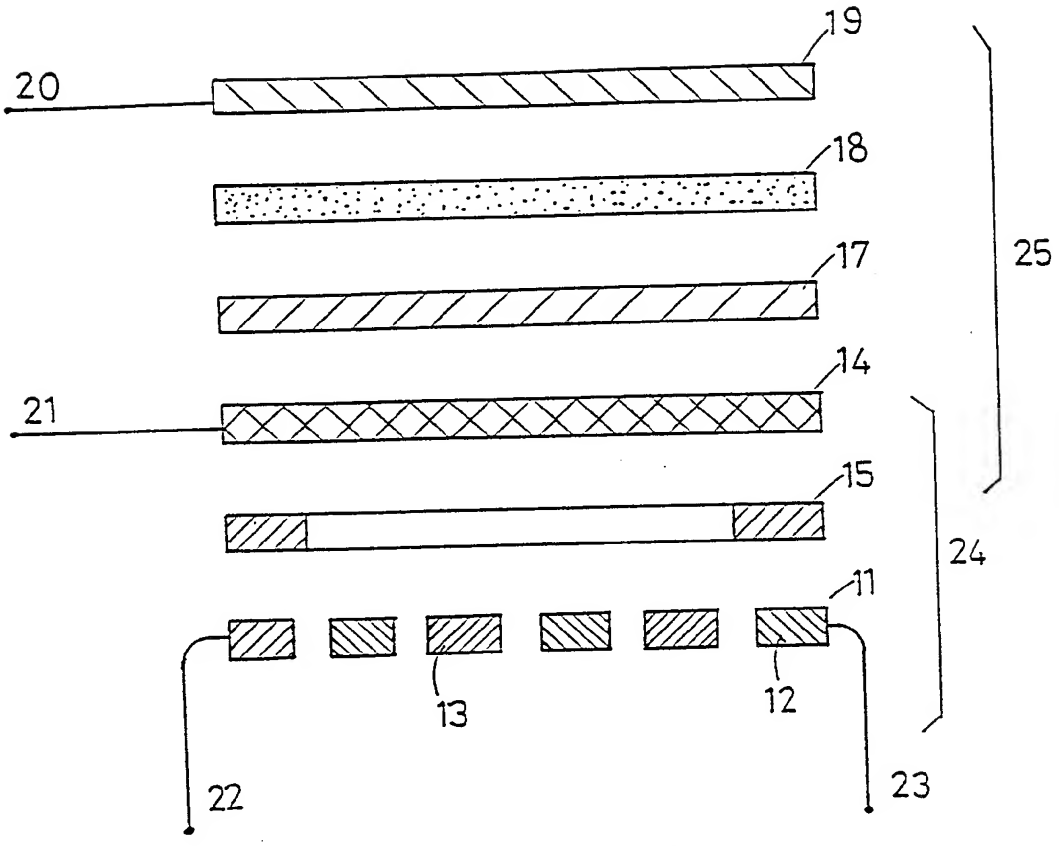

FIG.1

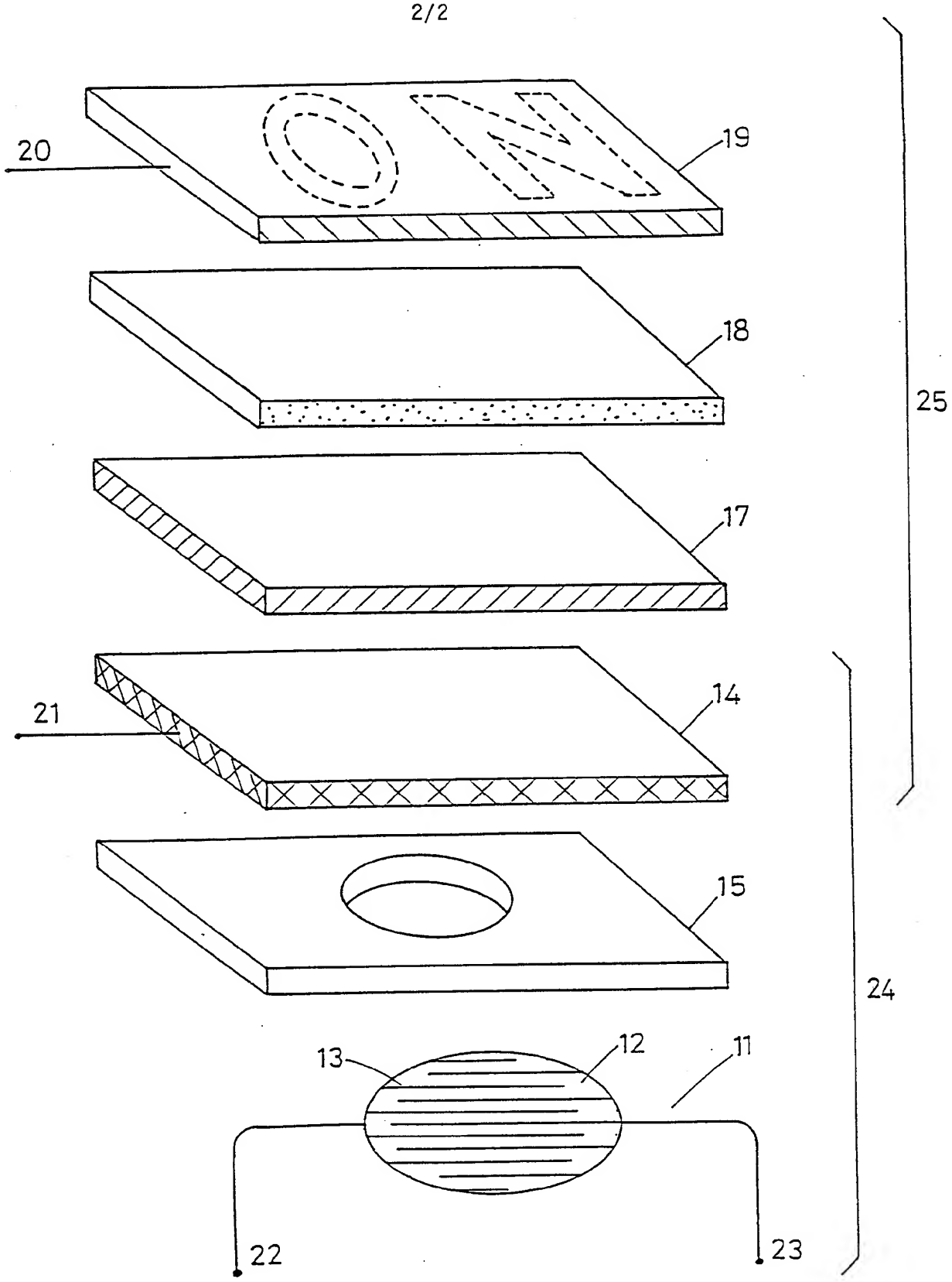

FIG. 2

INTERNATIONAL SEARCH REPORT

International application No.
PCT/NZ 98/00125

A. CLASSIFICATION OF SUBJECT MATTER

Int Cl[6]: H01H 1/16, H01H 9/16, H01H 11/06, H01H 13/70

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC: H01H 1/IC, 9/IC, 11/06, 13/70

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
AU: IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)
WPAT: IPC + ((MEMBRANE) AND (ELECTROLUMIN: OR LAMP # OR LIGHT: OR INDICAT:)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	GB 2260025 A (TOKYO SHIMODA IND LTD) 31 March 1993 Whole document	1-7
Y	EP 0753985 A (MATSUSHITA ELECTRIC INDUSTRIAL CO, LTD) 15 January 1997 Whole document.	1-7

[X] Further documents are listed in the continuation of Box C

[X] See patent family annex

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INTERNATIONAL SEARCH REPORT

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C (Continuation). **DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	Derwent Abstract Accession No. 97-250766/23, class V03 V04, JP 09082169 A (NIPPON KOKU DENSI II KOGYO KK) 28 March 1997	
A	US 4811175 A (DESMET) 7 March 1989	
A	EP 0134979 A (TIMEX CORPORATION) 27 March 1985	

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
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Patent Document Cited in Search Report		Patent Family Member					
GB	2260025	JP	5089743				
EP	753985	CN	1140972	EP	801517	JP	9035571
		US	5844362	JP	9035873		
EP	134979	US	4532395				

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